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THE GOVERNMENT'S SOLICITATION PROCESS AND  
WHETHER OR NOT IT IS DISCRIMINATORY  
TO SMALL BUSINESS

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Y 4. SM 1: 104-85

The Government's Solicitation Proce...

HEARING  
BEFORE THE  
SUBCOMMITTEE ON GOVERNMENT PROGRAMS  
OF THE  
COMMITTEE ON SMALL BUSINESS  
HOUSE OF REPRESENTATIVES  
ONE HUNDRED FOURTH CONGRESS  
SECOND SESSION

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DANVERS, MA, JULY 15, 1996

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Printed for the use of the Committee on Small Business

Serial No. 104-85



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# CONTENTS

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Hearing held on July 15, 1996 .....	Page 1
WITNESSES	
MONDAY, JULY 15, 1996	
Kern, Robert, President, Kernco, accompanied by Mike Delaney .....	3
Thidemann, Karl E., Director of Marketing, Solectria, .....	2
APPENDIX	
Opening statements:	
Torkildsen, Hon. Peter G. ....	12
Prepared statements:	
Kern, Robert .....	16
Thidemann, Karl E. ....	20
Additional material:	
An Improved GPS Cesium Frequency Standard .....	22



# THE GOVERNMENT'S SOLICITATION PROCESS AND WHETHER OR NOT IT IS DISCRIMINA- TORY TO SMALL BUSINESS

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MONDAY, JULY 15, 1996

HOUSE OF REPRESENTATIVES,  
SUBCOMMITTEE ON GOVERNMENT PROGRAMS,  
COMMITTEE ON SMALL BUSINESS,  
*Washington, DC.*

The Subcommittee met, pursuant to notice, at 11:05 a.m. at Danvers High School Conference Room/Curricula Center, Danvers, Massachusetts, Hon. Peter Torkildsen (Chairman of the Subcommittee) presiding.

Chairman TORKILDSEN. As Chairman of the Small Business Subcommittee on Government Programs, it is my pleasure to welcome everyone here today.

The hearing today will focus on the Federal Government's solicitation process. Specifically, the hearing will focus on the Government's method of soliciting requests for proposals, or RFP's, and whether or not the process discriminates against small business.

RFP's are the method by which Federal Agencies and Departments request bids on special projects to be awarded to private sector companies. The Agency or Department making the request may specify the contract as either open to set-asides or "unrestricted," meaning any company or individual may apply. Although this practice should apply to the small business community, some contend that unrestricted RFP's are often used as a means to exclude small business from competing for contracts.

Small business is the backbone of our economy, and certainly it has been growing at an impressive rate. Small business is the largest creator of jobs in our country. From December 1993 through December 1994, small business created 2.03 million new jobs, while big business actually lost more than 200,000 jobs.

According to the latest reports, small business accounts for 99.7 percent of the Nation's employers and they employ 54 percent of the private work force and are responsible for 50 percent of the private gross national product. In fact, small business-dominated industries produced an estimated 62 percent of the 3.3 million new jobs created in 1994.

In addition, small business contributes 52 percent of all sales to the U.S. and is responsible for 50 percent of the private gross domestic product. Small business gives more in charity to community service organizations per employee than do large businesses, according to the SBA's Office of Advocacy.



These statistics are outstanding and certainly indicate that small business is on the upswing and that it is vitally important to the economic well-being of our country.

Today, the Subcommittee will hear from two witnesses who state that they have been adversely affected by the Federal Government's practice of awarding contracts using RFP's. The Committee did have a third witness scheduled; however, the individual asked not to testify for fear of future action.

Due to the busy congressional schedule today, there will be no other members of the Committee attending this hearing. However, several members were quite interested in the outcome, and they have asked to see proceedings of this hearing.

With that, I welcome our witnesses today. I look forward to their testimony.

Our witnesses are Robert Kern, the owner of Kernco, Inc., a supplier for the Department of Defense and NASA in the area of hardware; and Karl Thidemann, Director of Marketing for Solectria, the largest independent maker of electronic vehicles in the United States.

I welcome both of our witnesses today and would like to ask Mr. Thidemann to begin his testimony.

#### **TESTIMONY OF KARL E. THIDEMANN, DIRECTOR OF MARKETING, SOLECTRIA**

Mr. THIDEMANN. Thank you. Good morning and thank you for this chance to testify on this topic of great concern to us.

We are here to express our concern that in a recent GSA public unrestricted bid, GSA RFP No. FCAP-F1-ELC97-N62696, due on June 26, 1996 Solectria Corporation and other smaller companies making electric vehicles were restricted from meeting the qualifications not based on uncompetitiveness, but rather solely because we are not a large automaker.

Specifically, the bid did not seek the best vehicles. Range, performance, experience and other relevant factors were not part of the bid at all, except as footnotes. The key criteria for eligibility to participate in this RFP was that "vehicles shall be supplied by" a bidder that first, is an Original Equipment Manufacturer, or OEM, defined as "a motor vehicle manufacturer who is responsible for the vehicle fuel economy of the gasoline version of the model supplied," which restricts the qualifier to only very large companies that also produce gasoline vehicles; or second, to an offeror that "must have an agreement with an OEM," one of the large automakers for warranty purposes.

Solectria Corporation is the largest independent maker of electric vehicles in the United States. We have made and sold approximately 250 electric vehicles, or EV's, in the last 4 years. This is more than all of the Big Three U.S. automakers combined.

Solectria electric vehicles have accumulated more than 1 million road miles in fleet and consumer applications, again, more than any of the Big Three. Our electric vehicles consistently excel and have frequently outperformed EV's produced by the large automakers in various publicly documented events.

Solectria EV's fully comply with all of the relevant safety criteria established by the U.S. Department of Transportation. Our electric



sedans and trucks have been found to be as safe as, or, in some cases, safer than, comparable gasoline powered vehicles.

Solectria electric vehicles now operate in 35 States throughout the United States, in climates and terrain ranging from the Arizona desert to the snowy mountains of Vermont. Solectria electric sedans and electric pickup trucks are now used at national parks, airports, including Logan Airport, and military bases nationwide. Many State governments and municipalities have chosen our vehicles in competitive bids and numerous private companies, including electric utilities from Oregon to California and Alabama to Maine, have decided to purchase our EV's following their bidding processes.

We brand our products Solectria and stand behind them for warranty purposes. We do buy a chassis and body from the large automakers, but we then add over 80 percent of the value to the vehicle before we sell it. We therefore believe we should qualify as an original equipment manufacturer, or OEM.

The GSA RFP referenced above does not allow for this. Although the GSA has latitude to waive this requirement if they so choose, Solectria spent considerable time and effort to put together our bid for these vehicles. We believe that we can provide the GSA with the best EV's available today. If we are screened out as the language of the bid implies, the Government will not get the best vehicles and our small business will have lost out for what we believe are inappropriate reasons.

Of additional concern is the precedent-setting nature of this bid. If small companies like Solectria are eliminated from eligibility at this stage, this could well put Solectria and other small motor vehicle suppliers at a competitive disadvantage in future bids.

I thank you very much for this opportunity to present the testimony today and would feel free to answer any questions.

[Mr. Thidemann's statement may be found in the appendix.]

Chairman TORKILDSEN. Thank you, Mr. Thidemann. We will hear from Mr. Kern before we have questions, but thank you very much for your testimony.

Mr. Kern, would you like to proceed with your testimony?

#### **TESTIMONY OF ROBERT KERN, PRESIDENT, KERNCO, ACCOMPANIED BY MIKE DELANEY**

Mr. KERN. Yes. Thank you again for this opportunity.

We are a small, high technology company but I have been participating in this business for some 30 years now, in both large corporate sized companies, such as Hewlett Packard and Varian to companies that we have started—Kernco being a 17-year-old Danvers, Massachusetts company.

We are very much involved in the Global Positioning System (GPS) which is a global navigation satellite system of great interest to the world these days. GPS is one of the technologies that America is noted for. In terms of supplying this global utility to all of the world we do not charge for it. It is something that our country is very proud of and something that I personally am very proud of.

I share the concerns of this committee because of observations and business experiences I have had that indicate a growing pat-

tern of disdain and distrust of small business by larger entities—be it the DOD or a Fortune 500 company.

Previous testimony to the U.S. Congress in January 1977 alluded to the situation that small businesses are not stable; are not adequately funded; and cannot handle this type of program. This was directly alluded to in the NAVSTAR Global Positioning System series of documents. These documents are available and seem to be a root for some of this attitude. The small business set-asides and the Federal Acquisition Streamlining Act of 1994, would seem to be more of a proactive approach for small business to do more for the country.

I would like to describe three personal experiences that reinforce my impressions. These observations are not intended to “point fingers” or “witch hunt” specific companies or Government Agencies, but they do illustrate a general pattern of behavior that effectively punishes small businesses by raising unwarranted concerns over financial stability depth of resources, reliance on key individuals. I think this is at the heart of the matter and I would like to illustrate my point by relating these experiences.

We have been involved for the past 6 years in building approximately 20 time and frequency “black boxes” to be launched on satellites. We are a small aerospace company, but we are quite successful. We have units operating in orbit which are the “best in show.”

We went ahead in early 1990 and bid our atomic clocks to support a major contract—it was called the Block IIR GPS Program—and we won. We competitively out bid a couple of the large aerospace houses. Before our contract award could be consummated, we were told to get a “big brother”—we were too small. We were forced to enter a joint enterprise agreement and work with a large manufacturing company. Kernco would do the development and the design, and a Fortune 500 company would do the production—for a mere 20 units.

That is still going on. It is greatly troubled now. We completed the development phase, we did the things small companies do. There is a lot of black art in some of our technology, but it has been transferred and it is just not working well in that environment.

In the middle of that time period in this same GPS Program, a design need arose for our customer to replace a concept that did not work and was competitively put out to bid. All of these bids, by the way, were unrestricted bids and there were no set-asides. Kernco bid this 40 piece unit and won that one. It was a situation where we had 6 months to perform and the whole satellite system depended upon it. I am very proud of our people. They responded; we have completed 50 percent of our shipments to date; and we are ahead of everybody else in this specific program. It defies the belief that small companies cannot respond. I think we have consistently demonstrated technical excellence as well as the ability to manufacture to success.

I might add that at that point in time, when we got the second job, there was no sense of anybody asking us to find a “big brother.” We were accepted as we were and proved we could deliver.

A second experience in 1995, involved an unrestricted solicitation for the next generation of 33 GPS satellites through the year 2017. We bid that one. Rockwell, who we previously worked with, gave us a letter that said we won the job hands down and were to supply 99 clocks. In the eleventh hour, Rockwell was forced by the USAF to bring alternate sources on. We could not have the whole thing even though the production rates were very low over the specified period of performance.

A third example of another unrestricted procurement that we competitively bid, resulted in Kernco receiving a Phase I award. We performed well in a 1-year period. The second phase was supposed to demonstrate hardware. After that Phase II bid was closed, the solicitation was reopened to insert a clause which would require our small business to violate our technology exchange agreement with Hewlett-Packard. We could not violate that agreement, so we were removed from that solicitation. We would not involve ourselves in lawsuits.

I think our proven performance is being pushed aside. I believe that costs to the Government are going up.

I believe our technology in this country is falling behind the rest of the world. I go to many international conferences, and have been pursued for some of this technology. The U.S. is expending significant resources but is losing our heritage advantage.

I think the cost factors, the performance factors and some of the delivery difficulties now experienced by the GPS Program could be resolved very simply by a realistic look at actual small business performance.

I would be happy to answer any specific questions.

[Mr. Kern's statement may be found in the appendix.]

Chairman TORKILDSEN. Thank you very much for your testimony.

To follow up in that line, Mr. Kern, I think the gist of what you are saying is that instead of just blanket treatment of all small businesses as being unable to guarantee completion of a contract, that you have some type of criteria in place based on both the number of units and known track record? Is that accurate?

Mr. KERN. I believe there is a distrust of small business because you cannot be a small aerospace company, and that worries the big fellows.

Chairman TORKILDSEN. Yes. I guess the point being in your particular case where at the time when you were only being called upon to produce 20 units, yet still the requirement was that you go out and, as you said, hire a big brother, if there was some type of criteria to say that, well, even though you are a small company, 20 units is not an exorbitant number. Obviously if it were some other type of product other than the one that you make, let us say one at 10,000 units, then obviously that might be necessary, but in this particular case, especially now where the numbers are small, just the same would apply for Solectria, too, because no one is going to start off by ordering 10,000 electric cars. I would assume at most it is going to be in the dozens.

Mr. THIDEMANN. This RFP was for 100.

Chairman TORKILDSEN. Yes, 100. Right. So, some small number. So, if the criteria were based not only on small business but would



be some actual attempt to look at the individual company and say can this company deliver the number of items required so it is not a blanket discrimination against small business.

Would something like that help, if we required a change in the process so that it was not an automatic assumption, that either you had to—in Solectria's case, only accept a large company or, in Kernco's case, Kernco would have to enter into a partnership whether they needed to or not.

Mr. KERN. The same company who questioned us and forced us into a partnership 2 years later never raised the question of a partnership. They knew we could do it, we had demonstrated it, and we went ahead and did it. But I think small companies are guilty until proven innocent.

Chairman TORKILDSEN. Under the current system. That very much needs to be changed.

Mr. Thidemann, if you could talk a little bit more about the situation there because the bias against small business in the bid process that Solectria was competing for seems even more onerous than the one that Kernco faced in that you were essentially denied a chance to be awarded the contract at all, whether you partnered with a large company or not, and in this particular case the language is that you pointed out in your testimony very much appears that it is a lock for one of the Big Three automakers.

I mean, is there anyone else that you know of that could even compete for that type of contract?

Mr. THIDEMANN. There is one quote-unquote conversion company, in other words, a company that purchases gasoline vehicles and converts them to battery-driven electrics, that right now has been working on an agreement with one of the large automakers. They are a company based out of Detroit.

To date, they have not even put any product out on the market, so there is no experience whatsoever with these vehicles. While they may prove in time to be suitable and worthwhile vehicles, we feel that the quality of the vehicle should come uppermost in the Government's strategy for selecting which vehicles to incorporate into their own fleet.

By excluding a company that has demonstrated to produce quality vehicles for no other reason than we are not a large automaker or have not chosen to enter into an agreement with an OEM seems inappropriate, for the reasons that I have tried to outline here.

I do not know if this responds to your specific query—

Chairman TORKILDSEN. It does. It clearly goes to one of the, I guess, distortions in the process by having this type of language there where you have just said that the only other company that might qualify is a company that has not produced any cars yet.

Mr. THIDEMANN. That is correct.

Chairman TORKILDSEN. So you have a company trying to jump through the hoops created by this language, yet they have no track record at all and yet they could be considered ahead of Solectria, even though Solectria has from your testimony, I think, manufactured 250—

Mr. THIDEMANN. That is correct.

Chairman TORKILDSEN. [continuing.] electric vehicles already.

Mr. THIDEMANN. Many of those have been sold to the Federal Government as well.

Chairman TORKILDSEN. So——

Mr. THIDEMANN. So we have a history of doing business with the Government.

Chairman TORKILDSEN. Clearly not only is the language that is in the bid now unfair, but it is creating what I would call a distortion, where a company that has never even made an electric car might be considered eligible for winning the bid, whereas the company that has the proven track record cannot even be considered. That, to me, is a major, major flaw and I think underlies the nature of the contract being discriminatory.

Mr. Kern, the nature of what Kernco does being very, very specialized, normally I would assume that is more of an asset, but, again, being specialized and a small high tech company, you are saying that that in this process can be a liability?

Mr. KERN. There has been a lot of Government meetings that describe it as a liability. We are leaders in our technology and in our business. Quality is not an issue in our business. We come under so many regulations with MIL Standard 9858; this is flight hardware that is documented to the nines. But they are afraid that with the technology base being centered in our company there have been statements made about Agencies have got to get the technology: know-how, show-how, out of our company into a broader market base. Our answer has been to bring people like Mike Delaney on board who is half my age to teach him everything I know and continuity. Mike is virtually running the company now.

This has not been an issue but it still is brought up in meetings and subcommittee meetings of the DOD, et cetera. We have taken special pains to offer to put drawings in escrow at bigger companies. But there is a paranoia on the part of some of these companies that, they must know everything we do. Our proprietary rights have been stretched beyond belief.

So it is a multifaceted thing that is insidious and I think Mike has well addressed it. He is living it more than I am every day now: it is very intense.

Chairman TORKILDSEN. Well, would you like to add anything about your experience dealing with the process? Because I am sure that that could be very helpful to the hearing.

Mr. DELANEY. Some of the issues that you brought up, past performance for example, are very important. I think if you look at past performance of a small company such as Kernco going it alone and doing the job ourselves, you will see that we have done a very good job. We have proven hardware now in orbit which is operating very well in the GPS system. Then you look at it and say, OK, you need to join that small company with a larger company because of whatever the paranoias are and the issues are with the contractors, the major contractors. You look at the track record at that point and a small company gets bogged down with some of the big company issues. Some of the Fortune 500 companies have to do things in certain ways that do not necessarily foster a small business environment and efficiency is not necessarily as good when a small company is influenced like that.

I think that when a small company is allowed to operate as a small company it works out very well. When major contractors try to come in and do some of the micromanagement, they want to see everything that you are doing every minute of the day. That is not necessarily something that we have the bureaucracy in place for in our company.

Chairman TORKILDSEN. But that is a regulatory cost that is very much there and, again, if you are a large entity, you may be able to afford the overhead involved in that, but if you are a small company then that obviously becomes an added cost to you that your larger competitors may already be dealing with and therefore do not have to add personnel for it.

Mr. KERN. If I may, we are getting gold stars for going through all the gates you have to go through—better than our big company brother. Whether it is a question of physical configuration or be it all sorts of audits that are done by the people in the DOD. We are going through all those gates and getting to the bottom of the hill just fine. So, in that sense, we have not had to apologize for our being a small business.

As a matter of fact, there's a lot of apologies on the table now from some of the big guys. I think the versatility of a small company is the ability to create the jobs and to move forward.

We are doing it the way it should be done and we do not find the smallness a negative. We find the attitudes toward smallness a negative. The attitudes scare me.

Chairman TORKILDSEN. Mr. Thidemann, have you found any of the compliance problems that Kernco has faced or as Solectria also been able to deal with the if micro management is the best term for it, how has Solectria's experience been on that?

Mr. THIDEMANN. We have had definitely to generate more documentation as we are participating in various Federal contracts over the years to the extent possible. We have been able to expand our staff as necessary and bring on folks to handle a lot of the paperwork. So far we have been dealing with it. I would not say that that has been specifically a big impediment to our process.

Just to follow up on another point that Mr. Kern made, was that we find that being in a smaller company gives us a great deal of flexibility. To the extent possible, we try to standardize our various designs so that we can produce vehicles more economically, more efficiently and so on. But when we do find that a design change is in order, it is very easy for us to implement it and put it into the next few vehicles within a matter of weeks or months, as opposed to the larger automakers which often require many years or even a decade to put in various design changes. We feel that this is one of the greatest strengths that we bring into the work that we do and why our vehicles are so successful.

Chairman TORKILDSEN. If we could talk now a little bit about the nature of your companies, how many people does Solectria employ?

Mr. THIDEMANN. Approximately 50 full-time.

Chairman TORKILDSEN. Fifty full-time? Your only location is in Wilmington?

Mr. THIDEMANN. That is correct.

Chairman TORKILDSEN. And how about Kernco?



Mr. KERN. We have 12 full-time people and probably about 8 part-time people, and we have been as high as 35 people. We are located in Danvers. That is our only location.

Chairman TORKILDSEN. That is your only location. Right. So, you are both very much the definition of small business. I mean, you are not nearly at the threshold where you are about to break into the large category, although obviously we always hope to see you expand to that point, but you are very much the definition of small business right now.

How many years have you each been in business?

Solectria?

Mr. THIDEMANN. Solectria was incorporated in 1989 and we sold our first electric vehicle in 1991. Prior to that, the founders of the team had basically been students at MIT building and racing solar cars and racing cars.

Chairman TORKILDSEN. So 7 years, right?

Mr. THIDEMANN. Yes. About 10 years of experience in the field but 7 years incorporated.

Chairman TORKILDSEN. As a company. OK.

And Kernco?

Mr. KERN. Ours was 1979, and we started producing hardware in 1982. We went through the development cycle. We went through a whole classic series of cycles, advanced development, engineering development and production. Things that we built in the 1980's are now in orbit and have been running for years and years in GPS. We heard the other day that another one is going up September 12. We have 2 of 24 satellites and we are in first and second place. I think we would be really discounted as a small business except when you look up and you look at your watch, it is kind of nice to have the best in show up there.

Chairman TORKILDSEN. Right. An impressive track record.

Well, are there any other points you think are relevant to make? I will be very much following up this with contact to appropriate executive branch officials about the problems that are in the RFP process now. I think you have made a very clear case why the current system is unfair, number one, if a bid is written to prevent a small company that actually is producing the goods from bidding on a contract at all, in Solectria's case, or in Kernco's case where even though you have a proven track record you are still required if you are awarded a contract to go into a partnership which by, I think, every objective measure would be unnecessary given your track record.

Is there anything else that you would like to add that may help reinforce those arguments on why the RFP process as it stands right now needs to be changed?

Mr. Thidemann?

Mr. THIDEMANN. Something that comes to mind specifically relative to the requirement, one of the requirements, that an offeror have the agreement for the warranty purposes related specifically to electric vehicles, we feel that this clause in particular lacks relevancy because warranty needs for electric vehicles are unlike those for gasoline powered vehicles to a very considerable extent. Electric vehicles in particular have very few of the components that frequently need warranty work that gasoline powered vehicles do,



other than replacing batteries on a period ranging from every 2 years up to every 5 years or so, depending on the nature of the batteries.

Many of our customers have not had to do any warranty or maintenance work on their vehicles literally because virtually all of the components are solid state or contain few or no moving parts. That whole aspect of electric vehicle technology makes that clause even less relevant than would otherwise be the case.

Chairman TORKILDSEN. What type of warranty requirements are there that are specific for electric vehicles?

Mr. THIDEMANN. Some of the considerations are the same. Of course, there are concerns about the steering and wheels and the suspension and other parts that are identical basically in the gasoline and electric version of the vehicle.

Most of the parts that require maintenance in a gasoline vehicle, for example, the spark plugs, exhaust systems, water cooling system, those components are removed completely from the electric vehicle, so those do not remain as issues that need to be dealt with at all. As the vast majority of the complete electric vehicle are parts that our company has designed and produced and installed and we know that. We have a very high degree of faith in their reliability. We feel very comfortable offering a full warranty on the vehicle for that reason.

Chairman TORKILDSEN. If you could provide perhaps like an item-by-item comparison then we can include that in the record.

Mr. THIDEMANN. We would be glad to.

Chairman TORKILDSEN. I think that will help as well. Obviously warranty is important in any type of Government bid, but obviously you want to make sure that the requirements of a warranty are what is necessary and you do not need to warranty a part of a car that is not included in an electronic vehicle. I would hope you could point that out.

Mr. Kern, anything else that you would like to add that, again, would help us in—clearly even if you do not have anything else to mention, it very clearly is a process that is in need of major improvement.

Mr. KERN. I think there is a small business advantage that is overlooked in general—certainly in very high tech industries. I think it is strongly related to the turnover issue. We deal with the U.S. Government, Lockheed-Martin, and other big guys where rotation occurs: rotation where you get somebody up to speed and then they are rotated out and you reset all the counters to zero and there is a whole new learning curve. With “right-sizing” and “down-sizing” taking place in the larger companies, it really turns out the technology stream, the technology memory, the corporate memory of a high-tech program dissipates. Most of our people have been with us more than 10 years.

I mean I worry about it—that we do not have turnover. I think maybe we have hardening of the arteries or something. But, we have the continuity. Often we get bad press because we say, oh, we did that back in 1973 and when you do this the outcome is negative. We have to reeducate all of the outside decision makers every couple of years. That is a real problem with some of the procure-

ment cycles as well. There is no "guru"—historian to hang in at these higher levels to know what is fact and what is fiction.

It is a new advantage of the small company. That never was that way years ago, but it certainly is prevalent these days with the high turnover rates.

Chairman TORKILDSEN. Both flexibility with an institutional memory at the same time.

Mr. KERN. Continuity.

Chairman TORKILDSEN. A pretty impressive—continuity is a pretty impressive addition and ability that you can offer. OK.

Well, if there are no further points, I would like to thank you for your testimony. I do think in the cases of both Kernco and Solectria you have underscored major problems in the bidding process right now and the Subcommittee will follow up with a report as well as a request for the executive department to review that. Hopefully we can make improvements in the process without having to resort to legislation. However, that is an option as well if we cannot do so administratively. Again, the changes that I think are necessary are very reasonable ones to allow.

In the case of Solectria, a company that has a proven track record to bid, to be considered for a bid for electric cars, I think that is only very reasonable. And, in the case of Kernco, to not be required to partner when their experience is otherwise. The changes we are asking for would not be specific just to these two companies, they would allow for companies across the board, as they should.

Any company with a proven track record in manufacturing should be considered for a bid if the taxpayers are requesting that product. Likewise, when the taxpayers are requesting high technology equipment, there should not be a regulation that says you have to assume a partner when no partner is necessary for the quality manufacture of those items.

With that, I would again say thank you for your testimony, and this hearing is adjourned.

[Whereupon, at 11:42 a.m., the Subcommittee was adjourned, subject to the call of the Chair.]

# APPENDIX

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PETER G. TORKILDSEN, MASSACHUSETTS  
CHAIRMAN

GLENN POSHARD, ILLINOIS  
RANKING MINORITY MEMBER

**Congress of the United States**  
**House of Representatives**  
104th Congress  
**Committee on Small Business**  
**Subcommittee on Government Programs**  
8-305 Rayburn House Office Building  
Washington, DC 20515

T-2

**OPENING STATEMENT**  
**CONGRESSMAN PETER G. TORKILDSEN**

**OVERSIGHT HEARING**  
**ON**  
**THE GOVERNMENT'S SOLICITATION PROCESS AND**  
**WHETHER OR NOT IT IS DISCRIMINATORY TO**  
**SMALL BUSINESS**

**JULY 15, 1996**  
**11:00AM**  
**DANVERS, MASSACHUSETTS**

Good Morning. As Chairman of the Small Business Committee's Government Programs Subcommittee, it is my pleasure to welcome you today. The hearing today will focus on the Federal Government's solicitation process. Specifically, the hearing will focus on the Government's method of soliciting requests for proposal (RFP's) and whether or not it discriminates against small business.

RFP's are the method by which Federal agencies and departments request bids on special projects to be awarded to private sector companies. The agency or department making the request may specify the contract as either open to set-asides or "unrestricted", meaning any company or individual may apply. Although this practice should apply to the small business community, some contend that "unrestricted" RFP's are often used as a means to exclude small business from competing for contracts.

Small Business is the backbone of our economy and certainly has been growing at an impressive rate. Small Business is the largest creator of jobs. From December 1993 to December 1994, small business created 2.03 million new jobs, while big business actually lost more than 200,000. According to the latest reports, small businesses account for 99.7 percent of the nation's employers, employ 54 percent of the private workforce, and are responsible for 50 percent of the private gross national product. In fact, small business dominated industries produced an estimated 62 percent of the 3.3 million new jobs created in 1994.

In addition, Small businesses contribute 52 percent of all sales in the United States, and are responsible for 50 percent of the private gross domestic product. Small businesses gives more in charity to community service organizations per employee than do large businesses, according to the SBA's Office of Advocacy. These statistics are outstanding and certainly indicate that small business is on the upswing, and that it is vitally important to the economic well being of our country.

Today, the subcommittee will hear from two witnesses who state that they have been adversely affected by the Federal Government's practice of awarding contracts using RFP's. The committee did have a third witness scheduled. Due to the fear of future retaliation by the contracting officers who make the awards, they declined to testify. They did not want to be placed on any list that might exist, possibly preventing them from future awards by the contracting officers.

Unfortunately, due to the very busy Congressional schedule this month, other members of the Committee are unable to attend. Several members were quite interested in the outcome of this proceeding. I will forward the record of this hearing to them.

With that, I welcome our witnesses and look forward to their testimony today.



15 July 1996

## DISCRIMINATION AGAINST KERNCO AS A SMALL BUSINESS

### Appendix "A" - To "Unrestricted" Procurements

Over the past eight years there appears to be an insidious pattern of events that leads us to the conclusion that Kernco, a Small Business, has been discriminated against by various Fortune 500 Defense Contractors and by agencies of the Government - perhaps misled by these companies. In support of this, we offer the following history of these events:

#### 1989 - Loss of Small Business Status on ITT Subcontract 413928

Kernco was coerced to enter into a Joint Enterprise Agreement (JEA) with SCI (a Large Business) by ITT Defense Communications Division as a condition for a contract award which was initially independently/competitively bid by Kernco. Despite Kernco's continued objections, our rights as a Small Business were not recognized on Subcontract 413928 and as a result we:

1. Were denied a higher progress payment percentage.
2. Were forced to use more of our funds than originally contemplated and today remain caught between three Fortune 500 companies which act in their own best interests.
3. Continue to lose money on a much delayed program - to a point where our company is at significant financial risk and under constant threats and coercion.

#### 1992 - SBA Complaint Filed ( VCXO IIR Program)

Kernco filed a complaint with the SBA through our local Congressman's office. This complaint was against ITT A/CD for alleged unfair treatment under a direct Firm-Fixed-Price contract (competitively bid) held with ITT A/CD - Subcontract No. 414861. Rather than responding directly to Kernco, ITT, without Kernco prior knowledge, sent it to third party (SCI). Since our complaints made no reference to our SCI partner or ITT Subcontract 413928, ITT acted improperly and gave SCI Kernco proprietary information - which SCI was



not authorized to receive and has subsequently been prejudicial in other contractual matters.

#### 1993 - 1995 - Broad Agency Announcement

Kernco responded to and received a bi-phase NRL BAA RFP for Advanced Cesium Clock Design Contract, N00014-94-C-2154 for Phase I (Feasibility Study). Our company supported pre-award efforts uniquely positioned us to deliver demonstrable hardware in a contemplated Phase II (Demonstration) follow-on contract. This second phase was to demonstrate the results of our Phase I Feasibility Study. Due to USAF pressure, the BAA Phase II follow-on was replaced by NRL Solicitation N00014-94-R-CP07 - which was totally funded by the GPS Joint Program Office. In the midst of the crucial Source Selection Process, USAF Capt. Hedenberg authored a "Memorandum for the Record" which states "currently, there is a monopoly on CAFS fabricators"; i.e. Kernco. The memo calls for a modular 'standard electronics' and 'physics package' architecture. This approach proposed by Capt. Hedenberg had previously been tried by the USN (unsuccessfully) on the O-1625 nuclear submarine Cesium clock program and would have required Kernco to violate legal agreements we executed with the Hewlett-Packard Company.

The timing of this memo and its proposed approach clearly affected the procurement action under Solicitation CP07; reeks of "anti-competition"; and suggests we hand over, at no charge, Kernco's and Hewlett-Packard's proprietary data.

#### 1994-1995 - NRL Solicitation N00014-94-R-CP07 Escapade

Kernco, in conjunction with the above BAA, assisted NRL in writing the Statement of Work (SOW) for CP07. After competitive bids were obtained by NRL (and Source Selection was well underway) the solicitation was reopened five (5) months later to add a paragraph into the SOW which had been removed during the initial review by NRL and Kernco. This paragraph, in effect, changed the complete scope of the SOW. Kernco would thus be required to violate existing Proprietary Exchange Agreements we executed with Hewlett-Packard and would thus require us to provide existing non-Government technology to NRL.\*

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\* See similar comments in both Hedenberg/and the Army Workshop summaries.

Although this contract contemplated multiple awards, it was subsequently awarded to only one contractor, Frequency and Time Systems (FTS) at a cost more than double that of Kernco's Small Business bid. Kernco's protest of award to the GAO was dismissed on the basis of timeliness of the protest submittal and thus did not respond to Kernco's reasons for the bid protest, which strongly questioned NRL's purchasing and Small Business practices.

### 1995 Events

A series of workshops sponsored by the DoD appear to provide further support identifying a pattern of discrimination against Kernco, Inc.

- In the Spring of 1995, the Office of the Under Secretary of Defense (Acquisition) held a broad based Special Technology Area Review (STAR) on frequency control devices - Kernco was the only Atomic Frequency Standard company excluded - although a GAO disbarred competitor (still disbarred) was invited. This, in spite of the fact that our previous Cesium units on orbit were, and remain today, as 'best in show' - while the other second source of Cesium Clocks ( the disbarred vendor ) has orbitally demonstrated equipment now totally inoperative. The final report does not even admit the very existence of Kernco, Inc.
- In August of 1995, an Army workshop was held at the University of North Carolina to discuss accuracy and anti-jam requirements for GPS. In "Discussions of Satellite Clocks; Clocks (Part I); summary Paragraph 9", we interpret this as both discrimination against age and Small Business. It also adds credence to the current DoD attitude to obtaining the proprietary rights of others; in our case, both Hewlett-Packard and our Small Business. (This paragraph overlays the JPO/USAF philosophy inherent in Capt. Hedenberg's 'Memo to File' credo).
- In late 1995 ITT acted in direct violation of Kernco's proprietary rights by providing Kernco's proprietary Cesium technology to Frequency and Time Systems (FTS) (an unsuccessful Block IIR bidder) and funding them to "second source" the CAFS (Kernco/SCI ) IIR Cesium Clocks using Kernco's technology. In spite of agreements

to protect Kernco's proprietary rights, ITT has provided equipment "know how" and "show how" to our FTS competitor. Kernco and FTS had both previously bid GPS Block IIF 13.4 MHz Cesium Clocks to Rockwell, Hughes and LMMS' for use in their long term, 33 satellite, Block IIF bid.

FTS, never having built a flight clock weighing 18.7 lbs., measuring 412 cubic inches requiring a mere 21 watts, and delivering a 13.4 MHz output with  $5 \times 10^{-14}$  stability, received dollars from Hughes to develop such a clock. Given they were handed our design by ITT after the IIF solicitation, it is our understanding that both Hughes and LMMS/ITT provided the USAF with improved best and final offers.

Kernco and FTS also bid GPS Block IIF 10.23 MHz Cesium Clocks to Rockwell. Kernco was notified in writing by Rockwell that it was chosen to be the single Block IIF Clock supplier. To our knowledge, FTS was advised by Rockwell of this decision. However, during the IIF USAF Q&A period Rockwell was directed by the USAF to have multiple clock suppliers and use two different clock types - Cesium & Rubidium !! This is in contrast to EG&G's current situation wherein their Large Business is the only IIR & IIF Rubidium supplier sanctioned by the USAF...(in spite of Kernco's offering of an alternate IIF source, lower cost, state-of-the-art **flight** Rubidium produced for the European Space Agency).

We do not understand either the logic nor the technical realities of this situation.

July 15, 1996



Hon. Peter G. Torkildsen, Chairman  
Subcommittee on Government Programs  
Committee on Small Business  
House of Representatives  
Congress of the United States  
B-363 Rayburn House Office Building  
Washington, DC 20515

Re: Testimony for Field Hearing on "Unrestricted" Government Requests for Proposal and their Effect on Small Businesses, Monday, July 15, 1996, 11:00 AM, Danvers High School

Dear Congressman Torkildsen:

I am writing to express our concern that in a recent GSA "public", unrestricted bid (GSA RFP No. FCAP-F1-ELC97-N-6-26-96, due June 26, 1996), Solectria Corporation and other smaller companies making electric vehicles were restricted from meeting the qualifications not based on uncompetitiveness, but rather solely because we are not a large automaker.

Specifically, the bid did not seek the "best" vehicles. Range, performance, experience and other relevant factors were not part of the bid at all except as footnotes. The key criteria for eligibility to participate in this RFP was that "Vehicles shall be supplied by" a bidder that (A.) is an Original Equipment Manufacturer (OEM), defined as "a motor vehicle manufacturer who is responsible for the vehicle fuel economy, of the gasoline version of the model supplied ..." (which restricts the qualifiers to only very large companies that also produce gasoline vehicles) OR (B.) an offeror that "must have an agreement with an OEM" (one of the large automakers) for warranty purposes.

Solectria Corporation is the largest independent maker of electric vehicles (EVs) in the United States. We have made and sold approximately 250 EVs in the last 4 years. This is more than all of the Big 3 U.S. automakers combined.

Solectria electric vehicles have accumulated more than 1,000,000 road miles in fleet and consumer applications -- again, more than any of the Big 3. Our electric vehicles consistently excel -- and have frequently outperformed EVs produced by the large automakers -- in various publicly documented events.

Solectria EVs fully comply with all of the relevant safety criteria established by the U.S. Department of Transportation. Our electric sedans and trucks have been found to be as safe as, or in some cases safer than, comparable gasoline powered vehicles.

SOLECTRIA CORPORATION  
68 INDUSTRIAL WAY  
WILMINGTON, MA 01887  
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508-658-2231  
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Solectria EVs now operate in 35 states throughout the U.S., in climates and terrain ranging from the Arizona desert to the snowy mountains of Vermont. Solectria electric sedans and electric pickup trucks are now used at National Parks, airports, and military bases nationwide. Many state governments and municipalities have chosen our vehicles in competitive bids, and numerous private companies -- including electric utilities from Oregon to California, and Alabama to Maine, have decided to purchase our EVs following their bidding processes.

We brand our products Solectria and stand behind them for warranty purposes. We do buy a chassis and body from the large automakers but we then add over 80% of the value to the vehicle before we sell it. We therefore believe we should qualify as an original equipment manufacturer (OEM).

GSA RFP No. FCAP-F1-ELC97-N-6-26-96 does not allow for this. Although the GSA has latitude to waive this requirement if they so choose, Solectria spent considerable time and effort to put together our bid for these vehicles. We believe that we can provide the GSA with the best EVs available today. If we are screened out, as the language of the bid implies, the government will not get the best vehicles and our small business will have lost out for what we believe are inappropriate reasons.

Of additional concern is the precedent setting nature of this bid. If small companies like Solectria are eliminated from eligibility at this stage, this could well put Solectria and other small motor vehicle suppliers like at a competitive disadvantage in future bids.

I have asked Karl Thidemann from Solectria to testify at your meeting on July 15 about this, as I will be out of the country at this time. Please feel free to contact me if I can be of further assistance.

Best regards,



Mark L. Dockser  
Vice President

## *An Improved GPS Cesium Frequency Standard*

*Terry Flanagan, Dennis Breuner and Charles McKnett/JAYCOR  
Leonard Cutler, Robin Giffard and Jack Kusters/Hewlett Packard  
Robert Kern, Michael Delaney and Jeffry Wisnia/Kernco, Inc.*

*Presented at*

*The Institute of Navigation's 1995  
National Technical Meeting  
Anaheim, CA*

*19 January 1995*

## AN IMPROVED GPS CESIUM FREQUENCY STANDARD

Terry Flanagan<sup>1</sup>, Dennis Breuner and Charles McKnett, JAYCOR  
 Leonard Cutler, Robin Giffard and Jack Kusters, Hewlett Packard  
 Robert Kern, Michael Delaney and Jeffry Wisnia, Kernco, Inc.

## BIOGRAPHIES

Terry M. Flanagan is Senior Vice President of JAYCOR, and has been involved in the design and test of Cesium frequency standards for GPS for more than 10 years.

Dennis Breuner is a Senior Scientist at JAYCOR who specializes in the analysis and radiation hardening of frequency standards.

Charles McKnett is a Senior Scientist at JAYCOR who specializes in the design of robust microprocessor subsystems for space and ground application.

Leonard S. Cutler is a Distinguished Contributor, Technical Staff, and Manager of the Precision Instrumentation Group at Hewlett-Packard Laboratories and was the technical leader for the design of the HP 5071A Cesium Standard.

Robin Giffard is a Chief Department Scientist in the Precision Instrumentation Group at Hewlett-Packard Laboratories and was responsible for much of the detailed design of the HP 5071A Cesium standard.

Jack Kusters is a Principal Scientist of Timing Solutions for Communications for Hewlett Packard, Santa Clara Division.

Robert Kern is the President and Founder of Kernco and the founder of Frequency and Time Systems. He has worked on Atomic clocks since 1962.

Michael Delaney is the Program Manager of Kernco's GPS IIR VCXO program.

Jeffry Wisnia is a Senior Design engineer at Kernco.

## ABSTRACT

The GPS/NAVSTAR Navigation Satellite System will be the mainstay of the NSS and must provide a global full coverage system through the late 90's and beyond. The heart of the GPS Satellite System is an atomic clock which maintains synchronous system time to generate

range and range-rate data for global users. Current GPS satellite Cesium frequency standards on which GPS timing depends, were designed in the early to mid 1980s. While these clocks have performed admirably on orbit, a new design for a Cesium frequency standard utilizing modern digital and RF technology offers significant advantages with respect to stability and environmental insensitivity, which taken together eliminate any perceived need for a clock temperature controller in the satellite. In this paper we describe a Cesium design that takes advantage of the fact that the Cesium standard is the only primary standard. The approach builds on the Cesium beam tube design and flight worthiness of our previous successful GPS Cesium standards married to Hewlett Packard's world recognized 5071A Cesium standard electronic and software design to achieve an optimized clock for GPS space application. The design provides advancements in the areas of performance optimization, stability, accuracy, extended useful life, reduction in environmental sensitivities, state of health diagnostics and clock system simplicity. In particular, the new design provides: immunity to environmental and aging effects, e.g., temperature, loop gain variations, magnetic and RF stability, and radiation response. Thus, the requirement for auxiliary environmental temperature control on the GPS satellite can be eliminated. Telemetry monitors that can indicate clock health and longevity, supplemented with additional data available to telemetry on command will allow engineering specialists to interpret trends and predict future performance and could even permit on orbit optimization of all performance determining operating parameters.

## 1.0 INTRODUCTION

The GPS/NAVSTAR Navigation Satellite System will be the mainstay of the NSS and must provide a global full coverage system through the late 90's and beyond. The heart of the GPS Satellite System is an atomic clock which maintains synchronous system time to generate range and range-rate data for global users. Current GPS satellite Cesium frequency standards on which GPS timing depends, were designed in the early to mid 1980s, from architectures evolved from commercial Cesium frequency standards<sup>1</sup>. While most of these clocks have performed admirably on orbit, the design architecture leads to



limitations in stability and inherent sensitivities to environmental fluctuations. In particular, a number of critical parameters that affect the environmental sensitivity and long term stability of the standard, e.g., Cesium beam tube applied magnetic field (C-field) and microwave power input level to the beam tube, are fixed during manufacture, but can change with time, with temperature, and with exposure to natural and nuclear radiaons in space. Designs have been developed to reduce these effects on the circuits which control these critical parameters,<sup>2,3</sup> but long term autonomous performance may still be affected by statistically variable component parameter changes. Status monitoring has been limited, and unacceptable performance will only be observed rather than predicted. One can predict that only marginal improvements in autonomous performance and predictability in space can be gained with conventional clock architecture.

In this paper we discuss a design philosophy that builds on the experience of previous GPS Cesium standards<sup>2,4</sup> along with the HP 5071A electronic and software design,<sup>5</sup> to achieve a state of the art clock for GPS space application. Because a Cesium standard is a primary standard that requires no external calibration, properties of the atom can be utilized to enable self checking routines to eliminate drift, to reduce environmental effects, and to control continuous optimization operations. The number of parameters that need to be controlled is small, since a Cesium standard does not exhibit chemical, pressure, or light sensitive shifts such as are inherent in secondary standards, e.g., Rb and H<sub>2</sub> standards. Taking advantage of inherent properties of the Cesium atom along with a new design approach for a space frequency standard utilizing modern digital and RF technology under microprocessor control offers significant opportunities with respect to stability and environmental insensitivity. The computing power of modern microprocessors with hard memory makes control of the standard and the storage and analysis of meaningful health and status monitors possible. The design approach uses legacies from our previous GPS successes, preserving many of the proven elements of those designs.

To illustrate the departures represented by the new approach, we will first briefly review the current designs.

## 2.0 DISCUSSION OF CURRENT SPACE CESIUM FREQUENCY STANDARD ARCHITECTURES

Several Cesium frequency standard designs have been developed for GPS space applications. A generic general block diagram representing the current architectures is shown in Figure 1. The output to the system (user) is

provided by a high quality voltage controlled quartz crystal oscillator (VCXO). Another output of the VCXO is buffered and frequency multiplied in a chain of harmonic generation circuits and filters, and low frequency FM modulation is introduced. Usually prior to the last stage of multiplication, the signal is mixed with the output of a synthesizer, phase locked to the VCXO, to obtain the microwave input to the beam tube at Cesium resonance frequency. The Cesium beam tube acts as a frequency discriminator whose output current varies approximately as the cosine of the difference between the frequency of the microwave input and the Cesium atomic resonance frequency. An error signal for the servo system is derived from synchronously detecting the tube output at the modulation frequency, and integrating the error signal to correct the VCXO.

Typical performance parameters for frequency standards based on this architecture are given in the first column of Table 1, and measured stability is shown in Figure 2 for a Kernco Block IIa unit. Models for performance in benign and in radiooon environments have been developed and verified, and circuit effects which limit long term stability and frequency drift have been identified.<sup>3,6,7,8</sup> Components and circuit limitations drive the temperature and environmental sensitivity of current standards. Components in the RF multiplier which set the gain and bandpass are adjusted during final setup; changes in the characteristics these components over temperature and with age changes the microwave power in the tube. The temperature coefficient is affected strongly by changes in microwave power.<sup>3</sup> Also, the C-field in the beam tube is fixed by component values which can change over time and with space radiaons. The servo loop within the standard that locks the quartz oscillator to the Cesium resonance frequency has traditionally been a first order loop, so that steps and drifts in the quartz resonator frequency and drift in servo loop components, e.g., integrator offset voltage, result in time errors. Also, long term degradation in components decreases the loop gain and therefore, the loop time constant, which translates to increased time error sensitivity.

## 3.0 NEW CESIUM STANDARD ARCHITECTURE AND DESIGN CONSIDERATIONS FOR SPACE

The basis for the new design for a GPS Cesium standard is the proven Kernco satellite Cesium elements combined with applicable electronics and software designs from the Hewlett Packard 5071A Cesium frequency standard described by Cutler and Giffard.<sup>5</sup> The block diagram for the new architecture is shown in Figure 3, where the microprocessor, memory, frequency multiplier chain, and telemetry controls and interfaces have been modified from

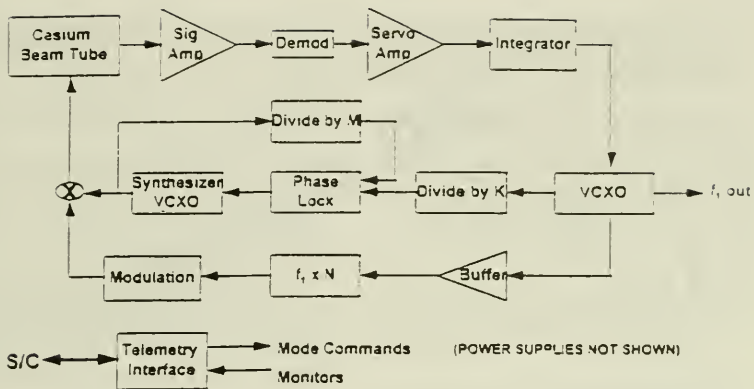


Figure 1. Typical GPS Cesium Standard Architecture.

Table 1. Design Requirements/Goals Comparison.

Characteristic	GPSIIR	New Design
Operating life	7.5 years	12 years
Power @ 28 V dc	22 W	23 W
Weight	21 lbs	22 lbs
Warmup	1 hour	30 minutes
Frequency Stability	Figure 2	Figure 5
Temperature Coefficient (-20 to +45°C)	$2 \times 10^{-13}/^{\circ}\text{C}$	NIL
Magnetic Sensitivity	$< 1 \times 10^{-12}$ for 2 Gauss	NIL
Radianon	7.5 yr Natural nuclear plus enhanced belts	TBR
Monitors and TC&C	Lock, 2nd harmonic monitors	Multiple health, status and interactive diagnostics

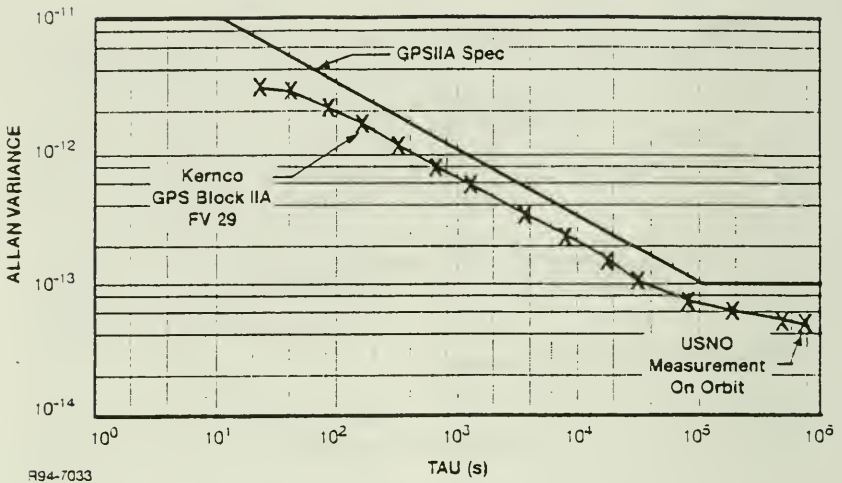


Figure 2. Frequency Stability for Current GPS Cesium Standards.

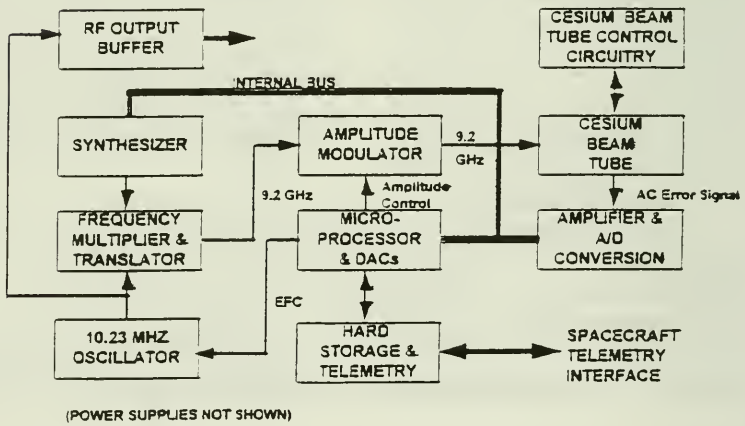


Figure 3. Block Diagram for Future Cesium Standards.

the 5071A design where required to suit the requirements of the GPS program.

The major departures from previous space Cesium standard architectures is the stabilization of key beam tube and servo loop parameters under microprocessor control.

**Microwave Power Control:** The output of a K4 Cesium beam tube versus input microwave frequency is shown in Figure 4. The field independent central peak is the resonance used for frequency lock to the quartz oscillator, and is expanded in the insert of Figure 4. The microwave power is servoed to maximize the dynamic signal amplitude at the two inflection points of the central resonance. It has been shown<sup>2,6,7</sup> that for slow square wave frequency modulation, this cancels the effects due to coherent amplitude modulation caused by, for example, beam tube microwave cavity detuning. This effectively reduces errors due to temperature variations to a negligible value.

**Beam Tube Magnetic Field (C-field) Control:** The servo loop controlling the beam tube's internal magnetic field takes advantage of a fundamental property of the Cesium atom; i.e., that the separation of the Zeeman transitions, the outlying resonance peaks in Figure 4, depends approximately linearly on the magnetic field times a constant determined from quantum mechanics. The C-field servo controls the current in the beam tube C-field coil so that the Zeeman splitting remains constant. This servo removes instabilities due to variations of applied magnetic fields, while maintaining a long term stability in the presence of space radiation and aging induced changes in the C-field current supply circuits. Servo control of the C-field removes a major term in the autonomous error budget, while reducing requirements on the long term stability of the C-field current supply.

**Servo Gain Control:** The servo gain is also controlled by the microprocessor, to maintain a constant value of the dynamic beam tube output signal as measured in the servo. This effectively maintains the time constant over the life of the standard, eliminating the effects of component aging and radiation induced degradation of performance.

**Second Order Frequency Lock Loop:** Locking the quartz oscillator with a digital second order frequency lock loop eliminates time errors due to drift and offsets in the servo integrator and in the quartz crystal oscillator. This implementation eliminates a major source of autonomous operation time error, and reduces the selection requirements for the servo integrator operational amplifier.

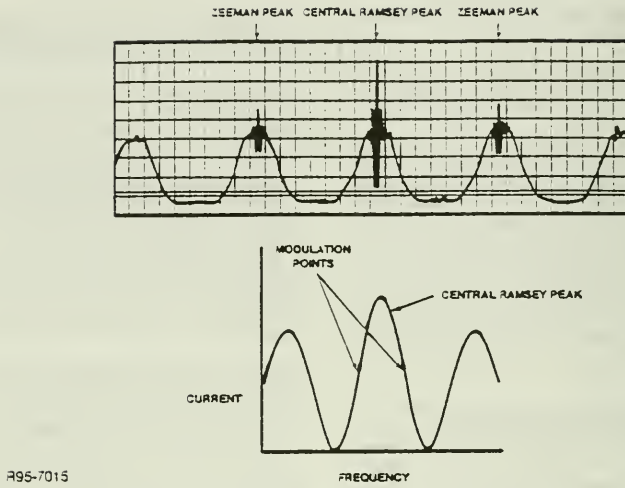
**Second Differencing:** Error signals are obtained by second differencing effectively removing offsets caused by drifts in the non-dynamic parts of the beam tube signal.

**Monitors and Controls:** Additional important benefits to Cesium architecture are made possible by the incorporation of a microprocessor. Two classes of monitoring information will be available. Health and status monitors will indicate that key parameters are within operational ranges or are close to predetermined limits. In addition, information from which to infer predictions about expected performance or life of the standard will be made available. Continuous monitoring of key parameters can be stored in hard memory in the standard. When the monitors indicate a limit approaching, or when more detailed information is desired, detailed parameter data can be downloaded upon telemetry command for analysis by specialists.

**Natural Space and Man-Made Radiation Effects:** The electronics must be designed for appropriate hardness in the natural and man made radiation environments anticipated for GPS. In particular, the microprocessor and other digital circuitry must be designed to be fault tolerant with respect to cosmic ray and proton induced upset and latchup. Design for rapid recovery from nuclear exposure can use the methods recently described by Flanagan et al.<sup>8</sup> for fault tolerant processors with non-upsettable memory. Recovery from single event or nuclear event upset with minimum time error will be facilitated by the second order frequency lock loop.

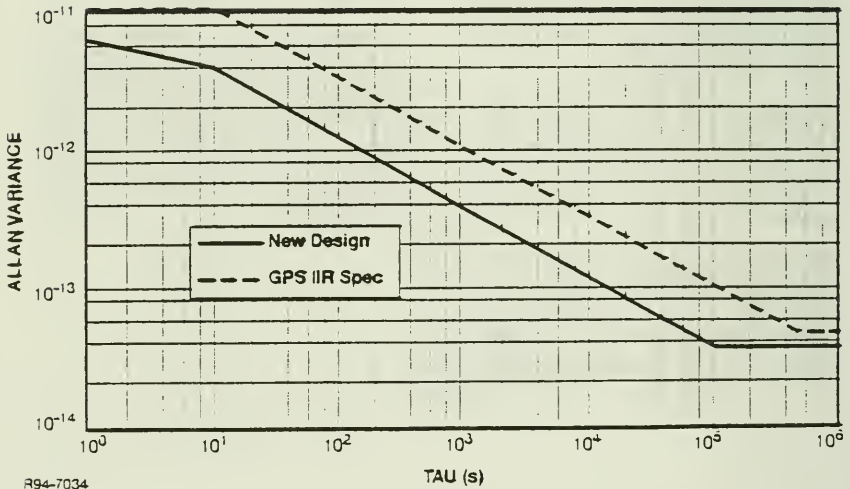
#### 4.0 SUMMARY AND CONCLUSIONS

A new architecture for a GPS Cesium frequency standard has been described which builds on actual hardware built for previous GPS flight application, and the realization of the HP 5071A. The new architecture overcomes the environmental effects on performance inherent in current designs, preserves legacy to critical functions and components which have been proven in space and promises unprecedented performance on orbit and could provide future users with real time state of health data. Key performance parameters for the new design are compared in Table 1.



R95-7015

Figure 4. Output Characteristics of a Cesium Beam Tube.



R94-7034

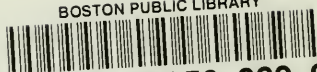
Figure 5. Cesium Frequency Standard Stability Expected for New Design.

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